National Aeronautics and Space Administration

Power Generation and Storage

Graphene Composite Materials for Supercapacitor Electrodes

Developing electrode composite materials that combine graphene with a metal oxide nanocomposite

NASA has developed an electrode composite material capable of both high energy density and high power density relative to conventional batteries. Electrochemical capacitors, or supercapacitors, have gained intense interest as an alternative to traditional energy storage devices in recent years. The applications for the supercapcitors range from plug-in hybrid electric vehicles (PHEVs) to backup power sources. While the power density of supercapacitors surpasses that of batteries, commercially available batteries have a significantly higher specific energy density. This innovation develops electrode composite materials that combine graphene with a metal oxide nanocomposite of manganese oxide and cobalt oxide. It comprises a scalable, integrated materials synthesis and device fabrication process to optimize specific capacitance as well as cycling life time and device reliability. Both energy density and power density are exceptionally high.

BENEFITS

- Allows for a scalable, low-cost fabrication scheme
- Increased energy density and power density
- Optimizes cycling life time and reliability
- Produced for less than a traditional battery

technology solution

THE TECHNOLOGY

The method is a two-step, low-cost, scalable solution process of reduced graphene oxide (rGO) and transition metal oxide nanostructures. The deposition of a hybrid metal oxide composite layer of Co304 and Mn02 is done on a current collecting substrate, followed by the electrophoretic deposition of a graphene oxide (GO) top layer. This top GO layer is then chemically reduced, allowing for significant conductivity while creating a porous, high surface area layer atop themetaloxide layer. Reduction typically is accomplished through the use of chemical agents, like hydrazine and sodium borohydride, or by high temperature treatments. The approach uses sodium borohydride as a supplementary reduction method. The variety of methods by which the hybrid metal oxide nanocomposite layer may be deposited onto different current collecting substrates makes this arrangement extremely attractive. Metal oxide nanowire arrays can be deposited using a huge variety of hydrothermal and electrodeposition methods. This range of methods by which the metal oxide component can be deposited onto a conductive substrate also allows for a high degree of flexibility in choosing of the current collecting substrate. The high porosity of the rGO layer is of great importance to allow sufficient diffusion of ions into and out of the metal oxide composite layer. The high specific area of the rGO allows for a high capacitive contribution from the Electrical Double Layer (EDL), while the metal oxide layer provides for a significant increase to the overall energy density of the electrode.

Renewable energy

APPLICATIONS

The technology has several potential applications:

- Electric Automobile power sources
- Sustainable Energy
- Renewable Energy
- Energy and Environmental Design

PUBLICATIONS

Patent No: 8,940,145

More Information

National Aeronautics and Space Administration

Technology Partnerships Office

Ames Research Center

MS 202A-3
Moffett Field, CA 94035
855-627-2249
ARC-TechTransfer@mail.nasa.gov

http://technology.nasa.gov/

www.nasa.gov

NP-2015-05-1818-HQ

NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

ARC-16812-1